Parallel Computer Network and Method for Telecommunications Network Simulation to Route Calls and Continuously Estimate Call Billing in Real Time

Cross Reference to Related Applications

This application is a continuation-in-part of co-pending patent application Serial No. 09/544,238, filed April 7, 2000, which relates to the same subject matter as provisional patent application Serial No. 60/184,537, filed by the same inventor on February 24, 2000. This application claims the February 24, 2000 and April 7, 2000 filing dates as to the respective common subject matter.

Background of the Invention

Field of the Invention

[001] The present invention relates generally to the field of computer networks, data accessing and processing systems. More specifically the present invention relates to a system of computers linked into a neural simulation network, or hive, with neural elements at remote sites which mimics and is placed in parallel operation, switch by switch, with an existing call routing telecommunications network to simulate the operation of the telecommunication network. The simulation network plots a call routing vector by forwardly chaining vector links through the simulation network and relaying as a response, or echo, the vector information so that the call is placed through the telecommunications network with maximum efficiency of bandwidth usage and computer capacity. Assume, for example, that the average call has seven call detail records (CDR). The present system correlates the billing entity locally, so that the system finds and sends only the one real CDR that the system has determined to have all the valid call components. The remaining six CDRs are thereby eliminated locally and are not transmitted to a central computer since they are redundant, and six sevenths, or 86 percent of bandwidth is saved.

[002] Thus the routing vector determines which telecommunications provider will own the call and thus determines the billing rate for the call, the rate information being incorporated into the call routing vector data. The billing rate is estimated from the moment the call is initiated, and the accuracy of the estimate increases as the call progresses so that billing takes places in real time. This billing method is known as a "fuzzy system" because it takes partial data samples and continuously projects an estimated total in real time. The more data exchanged through system messages that is through chaining, the more accurate the extrapolation becomes, until it reaches one hundred percent accuracy. The interactive simulation creates a data warehouse virtual environment.

Description of the Prior Art

[003] There have long been individual computers loaded with programs for routing telephone calls and generating billing for telephone and electrical utilities, which rely upon the processing power and data within the single computer. A problem with these single computer applications has been that more processing power and data access capability are needed, as well as increased bandwidth usage, together with web and virtual world access. Another related problem is that billing is not done in real time, which particularly complicates debiting of calling cards. Solutions to these problems are presented in the published doctoral dissertation of the present inventor, entitled Designing Hot billing Systems for Large Volume and or Complex Network, submitted for the degree of Doctor of Philosophy in Management for the present inventor at California Coast University in November of 1999, the entire contents of which are incorporated by reference. Also incorporated by reference are the contents of a provisional patent application filed by the present inventor on February 24, 2000, serial number 60/184,537, entitled Intelligent Component Billing System.

[004] U.S. Patent No 5,878,113, issued to Bhusri on March 2, 1999, discloses an exemplary telecommunications system that relies upon the operation of a single, central computer. The '113 patent discloses a system for service control and operations for a telecommunication network, wherein the system communicates with a plurality of interconnected telecommunications network elements via a switching and signaling

subsystem. The system provides and controls the various functions of the telecommunications network, such as call processing and routing, automatic fault detection and correction, interactive provision of services to customers, fraud detection and control, identification of patterns of network abuse, data collection of call activity at each network and network element, production of a data record for each network element, and production of a data record for each call placed within the network. To accomplish the aforementioned tasks, Bhusri relies upon a centralized mainframe computer. Consequently, the system disclosed by Bhusri is inherently susceptible to system faults, overloads and bottlenecks, since it is highly dependent upon the operation of the single central computer.

[005] U.S. Patent No 5,774,532, issued to Gottlieb et al. on June 30, 1998, discloses a telecommunications system incorporating a concentrator, or centralized mainframe computer, in which call records are generated from various network elements processing a call. A consolidation feed acts as a concentrator for the various records. However, since the concentrator receives the call records at different times, the invention provides the concentration with a count of different network elements that have to process the call. This allows the concentrator to match and merge the records after all of the records indicated in the final count have been received. In order to maintain the count, a buffer count is updated through the elements of the network used to build the call. As the volume of calls increases, the amount of duplicate data grows geometrically. Consequently, the centralized mainframe becomes increasingly susceptible to data congestion. Furthermore, the redundancy of the system does not enable real-time activities, such as billing and fraud detection.

[006] U.S. Patent No 5,949,875, issued to Walker et al on Sept 7, 1999, discloses a billing and collection system comprising an access management computer enabling payment, for a service provided over a data network, to be made for a telephone connection to a shared revenue billing network wherein the telephone connection to the billing network regulates access to the service provided over the data network. Walker discloses a system incorporating multiple computers each having specific functions. However, Walker discloses a centralized system in which multiple gathering computers having specific functions assist in processing information for a centralized mainframe

computer. Walker does not disclose a vector-based system enabling the performance of real-time functions such as real-time billing and fraud detection.

[007] U.S. Patent No 5,802,145, issued to Farris et al on Sept. 1, 1998, discloses a system and method for utilizing a common signaling network controlling a communications system for detecting predetermined events, executing predetermined events, and preventing a predetermined script upon detection of said events. This is accomplished strictly by building an SS7 vector route as the call travels through the different STP network elements. The monitors are programmed to trap and temporarily record predetermined data associated with specific events intended to be blocked or controlled. Therefore, Farris discloses a vector-based system enabling certain real-time activities. Specifically, the system is directed for use in providing real-time fraud detection and real-time detection of other predefined events. However, the system disclosed by Farris is not designed for, and does not enable, real-time billing or data manipulation to create a billable entity.

[008] U.S. Patent No 5,768,352, issued to Elliott et al. on June 16, 1998, discloses a system in which data incorporated in call detail records (CDRs), obtained from network switches, are subjected to processing by a statistics engine which maintains separate counts for CDR events relating to certain calls, such as 800 number and 900 number calls. Although Elliott discloses a system enabling real-time function, it is limited to a generalized statistical engine and thus does not include functionality necessary for real-time billing, fraud detection and comprehensive report generation summarizing the flow of funds.

[009] Accordingly, there is an established need for a telecommunications system overcoming the drawbacks and limitations of the prior art.

[010] In one aspect of the invention, a computer network system is provided that parallels and simulates an existing organization possessing a telecommunications network, so that the system does not tax the capacity of the existing network.

[011] In another aspect of the present invention a computer network system is provided which plots and updates a call routing vector for each call through forward chaining of vector links, and relays the vector information to the telecommunication network through rearward chaining for placement of all calls. The system determines

routing vectors for all calls, whether individually or for clusters of calls, from point A to point B and monitors and changes the vector as necessary to avoid a network trouble area or to maximize available bandwidth usage. Thus, the system analyzes, monitors and assigns a vector to each call that occurs in the telecommunications network. Furthermore, each node of the system has the latest real time network traffic patterns and conditions, enabling the nodes to make informed network traffic decisions.

[012] In another aspect of the present invention the computer network system plots a call routing vector providing the lowest billing rate available for that call at that moment and contains pricing data so that billing begins at the moment a call is initiated and continues in real time as the call progresses.

[013] In another aspect of the present invention the simulation network minimizes bandwidth usage by performing call routing calculations at individual junction points within the telecommunications network and sending only summarized information packets over network links.

[014] In another aspect of the present invention, a network system is provided that maximizes telecommunications network processing power by shunting calls from computers momentarily operating at or near capacity, and thus having smaller buffers, to less taxed computers having larger buffers.

[015] In another aspect of the present invention, the network system operates in conjunction with antiquated telecommunications technology, so that existing equipment is not wasted and the cost of updating/upgrading is minimized.

[016] In another aspect of the present invention, the network system performs network trouble-shooting functions aimed at minimizing down time and platform failure, by substantially immediately warning a repair crew of the nature and location of a problem. Preferably, in this manner, system integrity is maintained via a proactive preventative maintenance program.

[017] In another aspect of the present invention, the network system is relatively redundant and inexpensive to assemble and operate.

Summary of the Invention

[018] The present invention accomplished the above-stated objectives, as well as others, as may be determined by a fair reading and interpretation of the entire specification.

[019] A telecommunications call routing and billing computer system is provided, including a telecommunications network including a junction point, including a call routing switching device, and including two call routing links meeting at the junction point in communication with each other through the call routing switching device, and a call routing simulation network including a junction point simulation computer located at the junction point and in communication with the call routing switching device and the two call routing links.

[020] The call routing switching device is typically a telecommunications network computer. The telecommunications network typically includes a large number of the junction points, each including a call routing switching device, and each call routing switching device is connected to two call routing links which connect to other junction points; and the call routing simulation network typically includes a large number of the junction point simulation computers, each located at one of the junction points and in communication with the switching device at the given junction point and with the call routing links at the given junction point.

[021] A call routing and billing computer system is further provided for use in combination with a telecommunications network having a number of call junction points including call routing switching devices interconnected by call routing links, the telecommunication call routing and billing computer system including a simulation network including a number of junction point simulation computers networked to each other to function as a unit and to define a data warehouse virtual environment, each junction point simulation computer having its own location identification indicia, one of the junction point simulation computers being located at each of several of the call junction points to make switching decisions at each call junction point; the simulation network having computer programming to simulate the operation of the telecommunications network for each call placed through the telecommunications network by forward chaining of the call through the simulation network from the point of

call origin to the point of call destination to determine all of the links making up a routing vector for the call and to determine misuse of the resources, and by rearward chaining of routing vector information through the simulation network to the point of call origin.

[022] The simulation network preferably includes at least one parent simulation computer synchronizing and delegating tasks among a number of the junction point simulation computers. The simulation network preferably includes a hierarchy of parent simulation computers, each parent simulation computer synchronizing and delegating tasks among simulation computers lower in the hierarchy. Each call junction point typically includes a telecommunications network call routing switch. Each call junction point preferably includes a simulation network call routing switch. The hierarchy of simulation computers preferably additionally includes at least one dedicated computer for performing a specific task, and at least one processing computer for providing processing power to the unit. The simulation network may deliver summaries of routing information in the form of reports to a user computer terminal.

[023] The forward and rearward chaining preferably determines and relays estimated billing information to the telecommunications network as a call is placed in substantially real time. The junction point simulation computer location identification indicia each preferably include an identification number. The unit preferably is linked to a human user computer terminal. The system optionally additionally includes a strategy execution program which, stores parameters input by a human user for generation of certain commands in the events that data received from the virtual environment produces indicia meeting one of the parameters. The unit preferably additionally computes a bill for each call and generates a billing statement for delivery to the user. The links preferably include direct hyperlinks.

[024] A method is provided of placing a call through such a telecommunications network, including the steps of: placing one junction point simulation computer at each telecommunications network call junction point; for each call placed with the telecommunications network, plotting a call routing vector through the simulation network with forward chaining through the junction point simulation computers; and sending routing vector information back through the simulation network with rearward chaining to direct the call along a parallel routing vector through the telecommunication

network.

[025] The method preferably includes the additional steps of: monitoring buffer levels of telecommunications network junction point computers with the simulation computer at each junction point; and using the buffer level information to shunt calls from telecommunications networks junction point computers having smaller buffers to telecommunications network junction point computers having larger buffers. The method preferably includes the further step of: selecting a call provider offering the lowest rates during the forward and rearward chaining. The method preferably includes the still additional steps of: performing at every binary time interval a network diagnostic of the entire simulation network, and thus of the telecommunications network to detect system failure; and plotting new call routing vectors upon detection of a system failure which avoid the system failure, and can modify central office switches and change the route, thereby plotting new trajectory calls with real time data. Furthermore, it can also programmably modify route tables, trunk tables, add and remove users, and block, listen to or monitor and calls for security reasons. The hive simulation computers call each other to make sure the system is fully integrated. Placement of these calls is triggered by detected routing problems, and further user calls are then blocked where required. Thus we are optimizing the system for performance. In addition, each local data warehouse has the conditions and route patterns of the entire network. And with this information every time a call is initiated, the local hives know the exact routes of each specific call that goes through.

[026] In a further aspect of the present invention, particularly for use with a telecommunications network incorporating a plurality of call carrier billing entities, a method is provided for gathering and converting multiple independent billable segments of a telephone call into corresponding billing components for communication to a designated call owner in a manner enabling the call owner to effect billing immediately upon termination of the telephone call, but prior to network generation of billing component CDRs. Preferably, the telecommunications network covers a plurality of geographical regions, wherein each geographical region is subdivided into a plurality of Local Access Transport Areas (LATAs), each LATA is subdivided into a plurality of Number Plan Areas (NPAs), each NPA controls a plurality of NXX exchanges, and each

NXX exchange controls a plurality of Central Office (CO) switches.

[027] The method is comprised of the steps of: (a) integrating a parallel-distributed computer system into the telecommunications network to define a plurality of concurrently operating independent nodes distributed throughout the telecommunications network in a hierarchical arrangement comprising tiered groups of nodes within the network, a first tier group of said nodes strategically located within the network to monitor and control local call traffic within the NPAs, a second tier group of nodes strategically located within the network to monitor and control local long distance traffic within a LATA or a geographical region having multiple LATAs, and a third tier group of nodes strategically located within the network to monitor and control long-distance and international call traffic; (b) receiving a telephone call transaction request within the telecommunications network at a first node within said first tier group, the transaction request defining a first telephone number identifying a call origination point and a second telephone number identifying a call destination point; (c) receiving a vector call trajectory at said first node from the telecommunications network, the vector call trajectory comprising a plurality of vector segments defining a switch-to-switch pathway of said call between said call origination and destination points; (d) converting the vector call trajectory into a corresponding node-to-node billing trajectory bitmap; (e) identifying, at each node of said billing trajectory bitmap, which of the plurality of call carrier billing entities within a call billing segment associated with the node are being used and the associated call carrier costs; (f) alerting each of the nodes along the billing trajectory bitmap to generate a respective billable call segment for communication to a subsequently assigned call owner immediately upon receipt of a telephone call disconnect notification; (g) establishing ownership of the telephone call, at said first node, among said first, second and third tier groups; (h) assigning ownership of the call to a call owner node within one of said first, second and third tier groups; (i) receiving notification at the first node that the telephone call has disconnected; and (j) merging the individual billing components at said assigned call owner node. Additionally, each call owner node preferably assigns a unique system identifier to the call, wherein the first several digits, equal to the number of tiers in the hierarchy or a predetermined discrete value, represent the hierarchical position of the call owner node within the system, and the remaining

digits are derived from a unique sequential number of the call owner node. Alternatively, the unique system identifier can be derived by using the vector bitmap trajectory and then adding the aforementioned remainder digits derived from a unique sequential number of the call owner node. Preferably, the unique system identifier field should be more than ten digits in length.

[028] Preferably, the first node determines whether the call transaction comprises a billable connected call, after the telephone call transaction request has been received. Furthermore, the method preferably includes the step of receiving acceptance of call ownership from the assigned call owner node after notification is received at the first node that the telephone call has disconnected. Preferably, upon receiving notification at the first node regarding call disconnection, the call owner node transmits a message to the informed nodes along the billing trajectory bitmap including a unique system identifier corresponding to the telephone call transaction.

[029] In a further aspect of the present method, once one or more CDRs reflecting the actual costs of the billable call segments have been generated by the network, they are compared with respective billable call segments previously communicated to the assigned owner in order to confirm their accuracy. If they are accurate, a confirmation message is preferably communicated to the assigned owner node, including the unique system identifier. Alternatively, where a cost differential is determined upon making the comparison, the particular billable call segment is recalculated and communicated to the call owner node.

Brief Description of the Drawings

[030] Various other objects, advantages, and features of the invention will become apparent to those skilled in the art from the following discussion taken in conjunction with the following drawings, in which:

[031] *Figures 1 through 7 are included to show the complexity of large networks:*

[032] Figure 1 is diagram of two and four node networks;

[033] Figure 2 is graph showing how complexity increases with network size;

[034] Figure 3 is shows how management reduces complexity;

[035] Figure 4 shows a management synergy example between headquarters 1, 2, and 3 (HQ1, HQ 2, and HQ3);

[036] Figure 5 shows the linkage between Intelligent Billing System (IBS) and Total Quality Management (TQM);

[037] Figure 6 is a graph showing the complexity of multiple node networks;

[038] Figure 7 is a graph showing the complexity of single node networks;

[039] *Figure 8 through 14 show how calls occur within a present telephone network:*

[040] Figure 8 is a diagram of an Intra Central Office Call (HQ 0 parent);

[041] Figure 9 is a diagram of an Intra Exchange Office Call (HQ 0 parent);

[042] Figure 10 is a diagram of an Intra Numbering Plan Area (NPA), commonly know as area code, call (HQ 2 parent);

[043] Figure 11 is a diagram of an Intra Local Access and Transfer Area (LATA) Call (HQ 3 parent);

[044] Figure 12 is a diagram of an Intra Regional Call (HQ 4 parent);

[045] Figure 13 is a diagram of an Inter Regional Call (HQ 5 parent);

[046] Figure 14 is a diagram of an International Long Distance Call (HQ 5 parent);

[047] *Figures 15 through 23 show and describe how billing entity is generated using CDR as the source of data, according to the Doctoral Dissertation of the present inventor*:

[048] Figure 15 is an example of an Intelligent Component (IC);

[049] Figure 16 is an example of an intelligent Data Warehouse/Intelligent Network Information Warehouse (IDW/INIW);

[050] Figure 17 is a schematic representation of an IBS method of generating an IBS_Valid_CDR from a CO (Intra CO call HQ 0);

[051] Figure 18 is schematic representation of an IBS method of generating an IBS_Valid_CDR from a CO (Intra NXX call HQ1);

[052] Figure 19 is a schematic representation of an IBS method of generating an IBS_Valid_CDR from a CO (Intra NPA call HQ2);

[053] Figure 20 is a schematic representation of an IBS method of generating an

IBS_Valid_CDR from a CO (Intra LATA call HQ3);

[054] Figure 21 is a schematic representation of an IBS method of generating an IBS_Valid_CDR from a CO (Intra Regional call HQ4);

[055] Figure 22 is a schematic representation of an IBS method of generating an IBS_Valid_CDR from a CO (Intra Regional call HQ5);

[056] Figure 23 is a schematic representation of an IBS method of generating an IBS_Valid_CDR from a CO (International call HQ 5);

[057] Figures 24 through 30 show how to build a billing entity from network packets;

[058] Figure 24 is a schematic representation of an IBS method of generations an IBS_Vector_CDR from SS7 protocol packets (ISUP and/or ATM) Intra-Co call (HQ 0 Parent);

[059] Figure 25 is schematic representation of an IBS method of generating an IBS_Vector_CDR from SS7 protocol packets (ISUP and/or ATM) Intra-NXX call (HQ1 Parent);

[060] Figure 26 is a schematic representation of an IBS method of generating an IBS_Vector_CDR from SS7 protocol packets (ISUP and/or ATM) Intra-NPA call (HQ2 Parent);

[061] Figure 27 is a schematic representation of an IBS method of generating an IBS_Vector_CDR from SS7 protocol packets (ISUP and/or ATM) Intra-LATA call (HQ3 parent);

[062] Figure 28 is a schematic representation of an IBS method of generating an IBS_Vector_CDR from SS7 protocol packets (ISUP and/or ATM) Intra-Regional call (HQ4 Parent);

[063] Figure 29 is a schematic representation of an IBS method of generating an IBS_Vector_CDR from SS7 protocol packets (ISUP and/or ATM) Inter-Regional call (HQ% Parent);

[064] Figure 30 is a schematic representation of an IBS method of generating an IBS_Vector_CDR from SS7 protocol packets (ISUP and/or ATM) Inter-National call (HQ5 Parent);

[065] *Figure 31 through 37 show and explain in detail the geography and the*

actual Beowulf-like configuration for the system:

[066] Figure 31 is schematic sample Bell South telecommunications (BST) organizational hierarchy structure;

[067] Figure 32 is a schematic sample North Florida Network;

[068] Figure 33 is a schematic sample Central Florida Network;

[069] Figure 34 is a schematic sample South Florida Network;

[070] Figure 35 is a schematic sample Alabama-Georgia Network;

[071] Figure 36 is a schematic sample Tennessee-Kentucky-Mississippi-Louisiana Network;

[072] Figure 37 is a schematic South Carolina-North Carolina Network; and

[073] Figure 38 is a schematic representation of the parallel telecommunications and simulation networks.

Detailed Description of the Preferred Embodiments

[074] As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure.

[075] Reference is now made to the drawing, wherein like characteristics and features of the present invention shown in the various figures are designated by the same reference numerals.

The Basic System Element

[076] The essential element from which the system10 is constructed is a pair of network links, represented in Fig. 15 as Leg A and Leg B, meeting at a junction point in the form of a telecommunications junction point computer 34 functioning as a call routing switch (See Fig. 38). A junction point simulation computer 32 having a unique programmed identification number is connected to the telecommunications network junction point computer 34 to monitor the junction point computer 34 level of activity and simulate its operation. Vast numbers of these elements make up the parallel telecommunications and simulation networks. To optimize and verify system integrity, the system places a call which is first instantiated by the junction simulation computers, tagging junction points using identification numbers to construct a call routing vector, and then connected through the telecommunications network.

The System

[077] Referring generally to figures 1-38, and specifically to figure 38, the present system 10 replaces existing centralized large routing and billing computers with the simulation network 20, which comprises a hive of relatively inexpensive, smaller computers, interlinked as a hierarchy and including parent and junction point simulation computers 26 and 32, respectively, dedicated computers 22 for performing specific tasks

and other computers 24 to provide processing power and still others at the peak of the command hierarchy to synchronize and delegate tasks among the various interlinked simulation computers with continuous automatic reevaluation and redirection in real time. A parent computer 26 may be one computer or multiple computers working together in parallel using Beowulf-like technology, and this system 10 takes advantage of this technology to construct a supercomputer-like architecture at a very low cost. In this way, these smaller simulation computers are spread throughout the telecommunications network 30, and simulate the operations of the telecommunications network 30. The telecommunications network is divided broadly at certain junction points into local Access and Transport Areas hereinafter referred to as LATA'S, each of which may be one or more telephone area codes. Within each LATA and thus within the region of one or more area codes, one point of presence, hereinafter referred to as POP switches, there is a table of local Tandem Office Switches, hereinafter referred to as Tandems, which for example might be telephone exchanges defined by the first three numbers of a local telephone number. A call routing vector v is progressively constructed for each individual call by forward chaining through the simulation computers, through a series of the junction points separating LATA, point of presence (POP) switches within each LATA, Tandems within each POP switch, and ultimately the specific telephone numbers within each central office switch, hereinafter referred to as CO, which has the local loops or telephone lines.

[078] The simulation computers monitor activity and buffer levels of telecommunications computers 34 and use the information to make call routing decisions which shunt calls from telecommunications network computers 34 having larger buffers and to call providers offering the lowest rates. The simulation network 20 also saves bandwidth by making these call switching and routing decisions with the simulation computer 32 at each junction point and sending only information about the result of each decision to a parent computer 26 within the simulation hierarchy, rather than all of the information involved making each decision and by sending confirming vector routing information back to a parent computer 26 in the hive in small, summarized information packets which occupy minimal bandwidth. Furthermore, it is the task of the system 10 to define, which is the valid CDR that has all of the necessary information to create the true

billing entity, thus rendering the remaining CDR obsolete. System 10 integrity is monitored for rapid detention of malfunctions, so that proactive preventative maintenance is provided, thereby minimizing downtime. Hyperlinks are preferred over modems due to their larger bandwidth.

[079] In this way, the inventive simulation network 20 hive computers combine synergistically to minimize system 10 cost, to permit parallel simulation, to increase processing power, to minimize bandwidth usage, to permit forward and rearward chaining to maximize efficiency in telecommunications network computer operation and to permit real time fuzzy billing estimations so that billing begins as each call begins and progresses in real time. See Designing Hot Billing System for Large Volume and/or complex Networks, present inventor's copyrighted doctoral dissertation enclosed with parent application. The processing power and range of functions of the hive is greater than the sum of the processing powers and range of functions of each individual computer making up the hive.

Example

[080] An example of an application of the system would be in conjunction with a telecommunications network 30 spanning Florida and Georgia. Florida is divided into three LATA'S and Georgia is divided into two LATA'S. For calls placed from Florida, the simulation network 20 first links to parent simulation computers 26 controlling calls entering Florida, which check each of the three Florida LATA'S to see if the area codes within any Florida LATA match the dialed area code. This is a first step in forward chaining. The question of whether there is a match is answered with the sending of either a 'yes' or 'no' information packet. If there is a 'no' match, the parent simulation computer 26 directs the call to a parent simulation computer 26 controlling call routing in Georgia. Forward chaining further determines which tandems owns the call and a "vector V" is rapidly constructed. Then the completed information is sent through rearward chaining to the hive as a "billing entity", and also preserved locally in the given hive member computer. The information does not have to be requested, but is automatically sent, and decisions are made regardless of the quantity of data received. This permits the inventive real time billing provided by the present system 10, so that if the simulation

network 20 were placed on the internet, one could watch ones bill grow in real time as a call progresses.

[081] The parent simulation computers 26 continuously search for the providers giving the best rate at each moment to minimize the cost of each call. The rates of various providers may vary slightly from moment to moment depending in the varying call load experienced by each given provider.

[082] System 10, for example, re-routes calls to remote locations if local facilities are near capacity. This re-routing has a cost, but the parent simulation computer 26 weighs costs and suggests the most economical route to Italy or France, for example, so that the cost of the call is ultimately minimized. Calls are filtered to let just certain ones through, whether to MCI, A&T or to some other carrier.

The Method

[083] In practicing the invention, the following method may be used. The method of optimizing parameters of telecommunications call placement and billing tasks executed within a virtual environment using the above-described system 10 includes the steps of: placing discrete neural elements of a simulation network 20 in the form of junction point simulation computers 32, at telecommunications network 30 junction point locations; for each call placed with the telecommunications network, plotting a call routing vector v through the simulation network 20 with forward chaining through junction point simulation computers 32, and sending routing vector v information back through the simulation network 20 with rearward chaining to direct the call along a parallel routing vector through the telecommunications network 30.

[084] The method preferably includes the additional steps of: monitoring activity and buffer levels of telecommunications network junction point computers 34 with a junction point simulation computer 32 at each junction point and using the buffer level information to shunt calls from telecommunications network junction point computers 34 operating at or near capacity and thus having smaller buffers to computers 34 having larger buffers and to select a call provider offering the lowest rates at the moment the call is placed.

[085] The method preferably includes the additional step of performing at every

binary time interval a network diagnostic of the entire simulation network 20, and thus of the telecommunications network 30, and plotting new call routes in the case of a system failure or misuse of existing resources, such as inadequate use of network traffic routes. The result is lower downtimes because a repair crew is warned almost immediately and the system is maintained with a proactive preventative maintenance.

[086] The method is particularly adapted for use with a conventional telecommunications network incorporating a plurality of call carrier billing entities. Particularly, the method enables the gathering and conversion of a plurality of billable segments of a telephone call into corresponding billing components, for subsequent communication to a designated call owner. Particularly, this is accomplished in a manner enabling the call owner to effect billing immediately upon termination of the telephone call, but prior to network generation of billing component CDRs. A conventional telecommunications network covers a plurality of geographical regions, wherein each geographical region is subdivided into a plurality of Local Access Transport Areas (LATAs), each LATA is subdivided into a plurality of Number Plan Areas (NPAs), each NPA controls a plurality of NXX exchanges, and each NXX exchange controls a plurality of Central Office (CO) switches.

[087] Initially, the parallel-distributed computer system of the present invention is incorporated into the telecommunications network to define a plurality of concurrently operating independent nodes distributed throughout the telecommunications network in a hierarchical arrangement. In particular, the hierarchical arrangement is comprised of tiered groups of nodes within the network. A first tier group of nodes is strategically located within the network to monitor and control local call traffic within the NPAs. A second tier group of nodes is strategically located within the network to monitor and control local long distance traffic within a LATA or a geographical region having multiple LATAs. A third tier group of nodes is strategically located within the network to monitor and control long-distance and international call traffic.

[088] A telephone call transaction request is initially received within the telecommunications network at a first node within the first tier group, the transaction request defining a first telephone number identifying a call origination point and a second telephone number identifying a call destination point. Next, a vector call trajectory is

received at the first node from the telecommunications network, the vector call trajectory comprising a plurality of vector segments defining a switch-to-switch pathway of the call between the call origination and destination points. Next, the vector call trajectory is converted into a corresponding node-to-node billing trajectory bitmap. Subsequently, the system determines, or identifies, at each node of the billing trajectory bitmap, which of the plurality of call carrier billing entities within a call billing segment associated with the node are being used and the associated call carrier costs. Upon identifying the appropriate call carrier billing entities, each of the nodes are alerted along the billing trajectory bitmap to generate a respective billable call segment for communication to a subsequently assigned call owner immediately upon receipt of a telephone call disconnect notification. Subsequently, ownership of the call is established and assigned, at the first node, among the first, second and third tier groups. Upon receiving notification at the first node that the telephone call has disconnected, the individual billing components are merged at the respective assigned call owner nodes. After confirming that the call has disconnected, each call owner node preferably "brands" the call with a unique system number, or identifier, wherein the first several digits of the number represent the hierarchy of the call owner node within the parallel-distributed computer system, and the remaining digits comprise a unique sequential number of the call owner node. In this manner, each call can be accessed, monitored and tracked, in real time without any redundancy.

[089] Preferably, the first node determines whether the call transaction comprises a billable connected call, after the telephone call transaction request has been received. Furthermore, the method preferably includes the step of receiving acceptance of call ownership from the assigned call owner node after notification is received at the first node that the telephone call has disconnected. Preferably, upon receiving notification at the first node regarding call disconnection, the call owner node transmits a message to the informed nodes along the billing trajectory bitmap including a unique system identifier corresponding to the telephone call transaction.

[090] In a further aspect of the present method, once one or more CDRs reflecting the actual costs of the billable call segments have been generated by the network, they are compared with respective billable call segments previously communicated to the assigned

owner in order to confirm their accuracy. If they are accurate, a confirmation message is preferably communicated to the assigned owner node, including the unique system identifier. Alternatively, where a cost differential is determined upon making the comparison, the particular billable call segment is recalculated and communicated to the call owner node.

[091] While the invention has been described, disclosed, illustrated and shown in various terms or certain embodiments or modifications which it has assumed in practice, the scope of the invention is not intended to be, nor should it be deemed to be, limited thereby and such other modifications or embodiments as may be suggested by the teachings herein are particularly reserved especially as they fall within the breadth and scope of the claims appended.